

Sustainable Finance & Advisory

The next frontier: Embodied
carbon in commercial real estate

Executive summary

Embodied carbon comprises the emissions attributable to the construction of a new building, taking into consideration emissions related to raw material inputs, manufacturing, and transportation, as well as emissions related to the building's future demolition. At its core, embodied carbon intends to capture non-operational emissions from buildings, helping developers to gain a holistic understanding of the environmental impact of a new development.

- Embodied carbon is typically measured through a whole building lifecycle assessment, with emissions data for specific products pulled from environmental product declarations created by the manufacturer.
- Regulations, both in the U.S. and abroad, have been pushing for reductions in embodied carbon. California, for example, requires reductions for

large commercial buildings or large-scale reuse of existing structures. Some jurisdictions have rolled out incentive programs for developments that take steps to reduce embodied carbon.

- Disclosure frameworks, like GRESB and SBTi, and green building ratings standards, including LEED, increasingly are considering embodied carbon. Frameworks now enable the disclosure of embodied carbon metrics, while green building ratings standards award points for projects that actively consider and reduce their embodied carbon footprint.
- A number of new developments across various property types have demonstrated that embodied carbon can be reduced at little to no cost premium, though other challenges, including material availability, workforce familiarity, and balancing operational and embodied carbon remain.

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Understanding embodied carbon

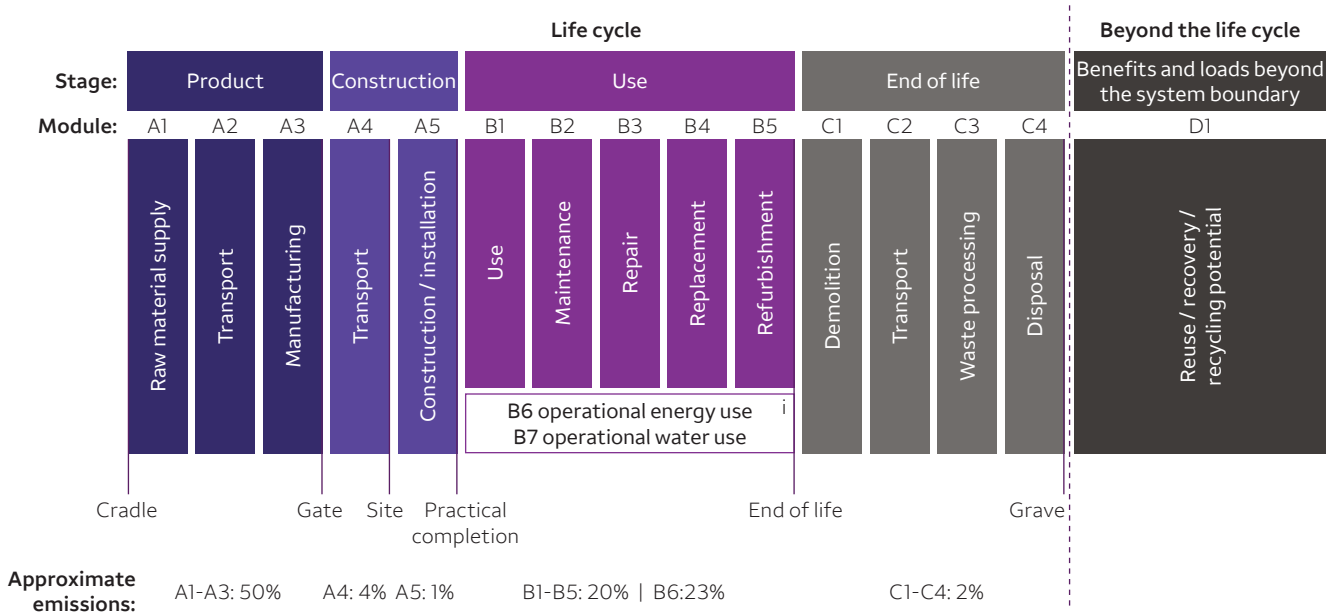
The commercial real estate industry is a major contributor to the world's greenhouse gas (GHG)* emissions, with 28% of global emissions attributable to day-to-day building operations and a further 11% attributable to embodied carbon.¹ As operational GHG emissions decrease due to improving building efficiency and grid decarbonization, embodied carbon will become a larger portion of the real estate industry's overall emissions profile, and, as a result, is beginning to draw more investor focus and regulatory scrutiny. Moreover, approximately 2.6 trillion square feet of new floor area is expected to be added to the global building stock by 2060, the equivalent of adding an entire New York City to the world every month for the next 36 years.² Because of the magnitude and permanence of the carbon impact, it is imperative that real estate developers and investors explore reducing embodied carbon in their projects.

Embodied carbon considers the GHG emissions associated with the production and transportation

of building materials, construction processes, maintenance, and eventual demolition of a building, and is expressed in kilograms of carbon dioxide equivalents.³ This is calculated by multiplying a carbon factor (kg of CO₂e per kg of material) by how much of that material is used in a project.⁴ This assessment is typically completed as part of a whole building lifecycle assessment (WBLCA), a holistic method of calculating the environmental impact of a building from cradle to grave.

Many manufacturers publish product emissions data within environmental product declarations (EPDs), which highlight carbon content, similar to how a nutrition label highlights caloric content.⁵ As of January 2024, there are estimated to be nearly 120,000 construction product EPDs globally, making selection of environmentally friendly construction products easier than ever.⁶

Scope of a WBLCA under EN 15978, an Increasingly Common WBLCA Standard⁷



i. Operational emissions are not a component of embodied carbon

Regulation has been driving consideration of embodied carbon

As sophistication has grown around reducing operational emissions in real estate, governments have turned their attention towards reducing embodied carbon by promoting greater disclosure,

and, in some cases, mandating reductions. The following chart highlights many of the jurisdictions pursuing embodied carbon regulation.

*Greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases.

Overview of Select Regulations Impacting Embodied Carbon

Regulation	Effective date	Description
United States		
Federal-State Buy Clean Partnership ⁸	March 2023	The federal government, along with 13 state governments, have pledged to prioritize the procurement of lower-carbon construction and infrastructure materials in government-funded projects.
CALGreen ⁹	July 2024	Commercial buildings (>100,000 square feet) and school projects (>50,000 square feet) will be required to comply with one of three embodied carbon management pathways: <ol style="list-style-type: none"> 1. Building Reuse – Reuse 45%+ of an existing structure and its exterior. 2. Performance – Complete a WBLCA demonstrating a 10% reduction in embodied carbon compared to a baseline project design. 3. Prescriptive – Document EPDs for a set list of materials that must be, on average, lower than a specified global warming potential** threshold (175% material average).
CA Assembly Bill 2446 ¹⁰	July 2025	The California Air Resources Board (CARB) is developing a framework (expected to be completed by the effective date in mid-2025) for measuring and reducing the carbon intensity of construction materials with a target of a 40% net reduction no later than the end of 2035, and an interim target of 20% by the end of 2030, from a baseline that will be established in 2026.
CA Senate Bill 253 ¹¹	Beginning 2026	Any U.S. entity (public or private) doing business in the state of California with global revenue more than \$1.0 billion will be required to report scope 1, 2, and 3 emissions in alignment with the GHG Protocol, which could include embodied carbon emissions for real estate developers. Currently, scope 3 reporting is scheduled to begin in 2027; scope 1 and 2 reporting will begin in 2026.
Boston: Net Zero Carbon Zoning (NZN) ¹²	July 2025	Approved by the Boston Planning & Development Agency in June 2024, this change to the zoning code is now pending approval by the city’s Zoning Commission. Once adopted, NZC will require projects filed after July 2025 to provide embodied carbon reports during planning and construction, among other requirements. Further, the code will require the majority of newly constructed buildings to be operationally net-zero at the time of construction.
International		
Canada Standard on Embodied Carbon in Construction ¹³	December 2022	Requires the disclosure of, and 10% reduction in, the embodied carbon of structural materials used in government projects valued at or above Can\$10 million (Can\$5 million beginning December 2024) and expected to use more than 100 cubic meters of concrete.
London’s Whole Life-Cycle Assessment ¹⁴	March 2022	Requires that carbon emissions associated with demolition of existing structures be calculated, as well as that a whole building lifecycle assessment be completed for in-scope replacement structures.

Investors and real estate disclosure frameworks are increasingly considering embodied carbon

Global Real Estate Sustainability Benchmark (“GRESB”) is an investor-led benchmark assessment for the real estate and infrastructure sectors. Over 2,000 property companies, REITs, funds, and developers, representing \$7.2 trillion in assets globally, submit to GRESB.¹⁵ Illustrating the heightened investor focus on embodied carbon, GRESB recently added a new embodied carbon indicator to its Real Estate Standard, meaning development companies now report on their embodied carbon initiatives

through the assessment tool. Embodied carbon is incorporated in both the disclosure-oriented section and the scored section. Points can be earned for conducting a WBLCA as well as for collecting EPDs for the building materials procured. In practice, this means that it will become increasingly difficult for real estate development firms to achieve top rated GRESB scores without integrating embodied carbon assessments and carbon reductions into business-as-usual practice.

**Global warming potential is a measure of how much energy the emissions of 1 ton of a greenhouse gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO₂). The larger the GWP, the more that a given gas warms the Earth compared to CO₂ over that time period.

The Science Based Targets Initiative (SBTi), a climate organization that defines and promotes best practices in emissions reductions in line with climate science, is developing guidance for the building sector to reach 1.5°C alignment. The organization's building sector

guidance aims to make embodied carbon targets required for new buildings within scope 3 reporting, surpassing existing guidance which is limited to operational carbon.¹⁶ Presently, 117 real estate firms have set targets with SBTi.¹⁷

Green building ratings standards are incentivizing embodied carbon reductions

The World Green Building Council has set targets for all new buildings to have at least 40% less embodied carbon by 2030, and for all new buildings to have net zero embodied carbon by 2050.¹⁸ Cascading from this directive, various national green building councils have taken steps to introduce their own guidance on embodied carbon reductions and measurement. Various green building ratings standards (GBRS), including the Living Building Challenge, LEED, and Green Globes have begun implementing point-scoring categories for firms that make use of more sustainable materials in construction.¹⁹

The International Living Future Institute's Living Building Challenge 4.0 is comprised of 20 different requirements, called Imperatives, with the energy and carbon reduction, net positive carbon, responsible sourcing, and net positive waste Imperatives all

featuring strong embodied carbon focuses. To achieve the responsible sourcing Imperative, for example, buildings must provide EPDs for up to 20 products, receive FSC certification for 50% of timber utilized, source 20% of materials locally, and divert 80% of construction waste from landfills.²⁰ Meanwhile, under LEED v4.1, points can be earned under the Materials and Resources credit category by conducting a WBLCA, obtaining EPDs, material ingredient reporting and optimization, responsible sourcing of raw materials, and waste reduction and management.²¹ Like LEED, Green Globes awards points for a myriad of actions, including conducting a WBLCA, selecting lower carbon materials (with EPDs), and reusing existing structural and non-structural elements.²² Altogether, these systems incentivize reductions in the amount of new material needed for a structure and more conscientious selection of building materials.

Adoption challenges

Change is never easy, and there are some barriers that could hamper widespread progress in the near term. One of the primary challenges is regional variation in the availability of low carbon material. As an example, the cement and concrete industry is highly localized. The average travel distance for in-situ concrete is 10 miles (16 km), while the average distance for concrete's raw materials is 30 miles (48km).²³ Cement and concrete producers must make capital investments to manufacture low carbon materials. An absence of market demand in the region can lead to hesitancy in pursuing those expenditures and result in fewer options for developers and contractors. This means that low carbon building products may have to be procured out of region at potentially higher prices, or not sourced at all. The federal government is doing its part to generate more demand for low carbon products. For example, General Services Agency's (GSA) Buy Clean program requires low carbon concrete and asphalt to be used in large

public projects, and further requires EPDs for those materials. Additionally, the IRA allocated \$4.5 billion specifically to the Department of Transportation, GSA, and Environmental Protection Agency to procure climate-friendly construction materials for federally funded projects.²⁴ These initiatives may help to scale production of low carbon materials, creating positive externalities for the real estate sector.

Workforce education is another significant challenge, with professionals across the design, engineering, construction, project management, insurance, and regulatory landscape needing to better familiarize themselves with product innovation and techniques. For example, an engineer could specify the use of higher-grade steel to accomplish the same structural task using less material. However, design and product selection are important to ensure that the increased strength of the material does not result in additional CO₂ emissions.²⁵ As another example, insurance

providers have struggled to properly assess the risk and resiliency of new innovative building products. Products like cross-laminated timber (CLT), dowel-laminated timber (DLT), and glue-laminated timber (glulam) have undergone extensive testing and meet, and in many cases, exceed, fire performance standards when compared to traditional building materials.^{26,27} However, given the nascency of these products, insurance companies tend to assign a higher premium to mass timber structures compared to those made of conventional materials.²⁸

Once the workforce is seasoned in understanding recent advancements in building products, striking the appropriate balance between operational and embodied carbon is critical. This delicate balance was

recently addressed in a ULI report, *The Carbon Sweet Spot: Design Tradeoffs for Embodied and Operational Carbon in New Buildings*, which explored this dynamic with three distinct case studies. The report suggests that to achieve an optimal outcome, a WBLCA should be leveraged in combination with considerations such as local climate conditions, the clean energy proportion of local electrical grids, and the regulatory environment around climate and building decarbonization to make informed decisions.^{29,30} As an example, triple- or quad-pane window glazing can be utilized to reduce operational emissions in colder markets with building performance standards tied to energy use intensity. This product choice results in a higher embodied carbon footprint and upfront cost but may be appropriate considering the bigger picture.

Demystifying low carbon development

Despite adoption challenges, there are increasingly more case studies illustrating high-profile developments across the globe that have successfully balanced cost considerations, embodied carbon, and operational efficiency, including:

- Hines' development, Salesforce Tower Chicago, a 1.2 million square foot, 60-story building completed in December 2023, was the first building in the city to require and measure EPDs for its construction materials. Seeking to reduce embodied carbon, Hines focused on concrete mix formulations and steel procurement, reducing emissions from those products by 27% and 9%, respectively. Altogether, the entire structure contained 19% less embodied carbon than at baseline without any additional cost premium.³¹
- Prologis' Eindhoven DC4 warehouse in the Netherlands is a leader in both operational and embodied carbon. Featuring an all-electric heating system and responsibly- and locally-sourced concrete, the warehouse stands as a model for net-zero construction. By 2030, total emissions from construction will have been offset by the generation of onsite renewable energy, which outsizes the facility's power needs by a factor of two. The tenant, GXO, has a strong sustainability strategy of its own, and is proud to occupy the first logistics facility in the world with a Zero Carbon Certification.³²
- Lendlease's mixed use development at 3401 S. La Cienega Blvd in Los Angeles ("La Cienega") is another project that makes reductions in embodied and operational carbon central to the development plan. Currently under construction, Lendlease procured low-carbon materials, including steel, concrete, aluminum, and glass, to reduce emissions from materials, while electrified construction equipment further reduced embodied carbon. In addition to these initiatives, the development has been designed to achieve LEED Gold in its residential portion and LEED Platinum in its office portion. An all-electric utility system and use of on-site renewables makes the project a model in large-scale sustainable development.³³
- Skanska, a global construction company, has achieved significant reductions in embodied carbon across three case studies with negligible impact on total project cost. In a 200,000 square foot mid-rise concrete and steel office building, Skanska realized a 46% reduction in embodied carbon at a 0.50% premium. A similar reduction and premium was realized for a 125,000 square foot stick built multifamily development, while the firm reduced embodied emissions by 19% at a 1.00% premium for a 360,000 square foot tilt-up warehouse.³⁴

Embodied carbon incentives

To drive progress, there are emerging incentives that aim to support embodied carbon reductions in real estate. For example, Colorado offers an exemption on its state sales and use tax for the purchase of eligible materials that meet a set global warming potential. Cities including Austin, San Diego, Los Angeles, and many others, have laws in place to incentivize the reuse of existing structures and/or the use of recycled materials in construction.³⁵ Additionally, embodied carbon is increasingly being integrated

into sustainable finance to provide differentiated pricing and outcomes. For example, Equinix and Great Portland Estates are two firms that have explicitly referred to embodied carbon in their green finance frameworks allowing for allocation under existing green bonds.^{36,37} Further, lenders such as Wells Fargo have created loan program enhancements for developments meeting certain criteria like completion of a WBLCA, collection of product specific EPDs, and obtaining green building certifications.

Conclusion

As investors and regulators advance progress in reducing operational emissions, embodied carbon is clearly the next frontier. Early adopters are designing new buildings with an eye towards reducing embodied carbon, engaging with supply chains to procure low carbon building materials, and quantifying whole building life cycle carbon to provide emissions

transparency to a broad array of stakeholders. This strategy is supported by a broad range of sustainable finance products and third-party incentives to reduce adoption barriers. Wells Fargo's Sustainable Finance & Advisory team is prepared to engage with clients about how sustainable finance can support their sustainability strategies and implementation.

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2. Architecture 2030, "[Why the Built Environment?](#)"
3. U.S. Environmental Protection Agency, "[What is Embodied Carbon?](#)"
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5. Rocky Mountain Institute, "[A Primer on Embodied Carbon in Climate Disclosure](#)"
6. Eco Platform, "[EPD Facts & Figures](#)"
7. The Institution of Structural Engineers, "[A brief guide to calculating embodied carbon](#)"
8. Office of the Federal Chief Sustainability Officer, "[Federal-State Buy Clean Partnership Principles](#)"
9. AIA California, "[CALGreen Mandatory Measures For Embodied Carbon Reduction](#)"
10. Stok, "[California Embodied Carbon Law: How to Prepare for AB 2446](#)"
11. California Lawyers Association, "[California's Climate Disclosure Requirements](#)"
12. City of Boston Planning Department, "[BPDA approves Net Zero Carbon Zoning](#)"
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- 15.GRESB, "[Real Estate Assessment](#)"
16. Ramboll, "[What the new SBTi building guidelines mean for the real estate industry](#)"
17. Science Based Targets initiative, "[Target Dashboard](#)"
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19. Structural Engineering Institute, "[Embodied Carbon in Green Rating Systems](#)"
20. Structural Engineering Institute, "[Embodied Carbon in Green Rating Systems – International Living Future Institute's Living Building Challenge 4.0](#)"
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23. Materials Palette, "[The Emissions Impact of Concrete](#)"
24. Carbon Leadership Forum, "[2022 Embodied Carbon Policy – A Year in Review](#)"
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26. Naturally: Wood, "[Fire Performance](#)"
27. Think Wood, "[4 Things to Know About Mass Timber](#)"
28. Woodworks, "[Insurance for Mass Timber Construction: Assessing Risk and Providing Answers](#)"
29. Urban Land Institute, "[ULI Report: Balancing Embodied and Operational Carbon Emissions from New Buildings is Critical for Long-Term Decarbonization](#)"
30. Urban Land Institute, "[The Carbon Sweet Spot: Design Tradeoffs for Embodied and Operational Carbon in New Buildings](#)"
31. Hines, "[Our plan in action: Reducing embodied carbon at Salesforce Tower Chicago](#)"
32. Prologis, "[Not your Father's Warehouse: World's First Zero-Carbon Certified Logistics Building](#)"
33. Lendlease, "[Scoping Out the Path to Absolute Zero: How we plan to tackle Scope 3](#)"
34. Rocky Mountain Institute, "[Reducing Embodied Carbon in Buildings](#)"
35. Carbon Leadership Forum, "[Policy Toolkit](#)"
36. Great Portland Estates, "[Sustainable Finance Framework](#)"
37. Equinix, "[Green Finance Framework](#)"

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